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LISTER AS PHYSIOLOGIST[1]

IN his article on Baron Lister in the eleventh edition of the Encyclopaedia Britannica, Sir Clifford Allbutt says that Lister, appraising his own work, once stated that he had done no more than seize upon the discoveries of the great French scientist, Louis Pasteur, and apply these discoveries to surgery. The writer of the article then goes on to say, "But though Lister saw the vast importance of the discoveries of Pasteur, he saw it because he was watching on the heights; and he was watching there alone." How are we to account for the unique preparedness of Lister to lay hold of the revolutionary work of Pasteur and to apply it with such momentous effect to the treatment of surgical wounds? How had he reached those heights on which he stood watching alone?

The various biographical accounts of Lister all contain references to the early physiological work that he carried out. They make plain that he approached his surgical problems with the peculiar experimental outlook that is acquired through physiological training. In his Huxley lecture delivered in 1900 before the Medical School of Charing Cross Hospital he gives a charming review of these introductory researches, and thus outlines the influences that were brought to bear upon him at the commencement of his career:

> As a student at University College I was greatly attracted by Dr. Sharpey's lectures, which inspired me with a love of physiology that has never left me. My father, whose labours had raised the compound microscope from little better than a scientific toy to the powerful engine for investigation which it then was, had equipped me with a first-rate instrument of that kind, and I employed it with keen interest in verifying the details of histology brought before us by our great master. When I afterwards became house surgeon under Mr. Erichsen, I applied the same means of observation to pathological objects.

In other words, through physiology and physiological investigation Lister became what we should now call an experimental pathologist.

Let me digress for a moment to speak of some of his teachers. He makes mention of his father's improvements on the microscope. The father, a London wine merchant, a skilled mathematician and a world-renowned expert on optics, was a fellow of the Royal Society and known to a large circle of scientific people, biologists and astronomers. He had once col-

[1] Lister Centenary address delivered in the Moyse Hall, McGill University, Montreal, April 5, 1927.

laborated with the physician Hodgkin in microscopic examination of the red cells of the blood. Those two men together first established the real shape of the red corpuscles, and described their peculiar aggregation in rouleaux (1827).

When the son at the age of twenty-one began his medical course at University College, London, he came under the influence of some unusually able teachers. One was the professor of chemistry, Thomas Graham, whose work on colloids and on diffusion of gases has made his name so famous. The influence of Graham may be detected in many of Lister's subsequent papers. The men, however, to whom he owed most in the way of direct inspiration were Wharton Jones, professor of ophthalmic medicine and surgery, and William Sharpey, professor of physiology.

Wharton Jones, a shy, retiring and somewhat eccentric man, little known to the world at large but held in high esteem by a circle of intimate acquaintances who understood his scientific quality, devoted all the leisure that he could spare from practice to physiological inquiry, working particularly on the blood and on the circulatory system. To him, the original discoverer of amoeboid movement in the blood leucocytes, we owe an elaborate and comprehensive survey of these cells, which he classified into two main varieties, hyaline and granular, distinguishable not only by their appearance and configuration but also by their behavior on a glass slide. This work, published in 1846, *i.e.*, when Lister was a student, forms the foundation of all our subsequent knowledge of these interesting and vitally important blood elements. His researches on inflammation were the direct means of inducing Lister subsequently to pursue the subject.

Lister's chief incitement to scientific investigation came from William Sharpey, to whom his country owes a lasting debt as the outstanding exponent of the experimental method in biology at a time when England lagged far behind her continental neighbors in such inquiries. By the unwonted clarity, by the stimulating quality of his lecture-room exposition, combined with a wide knowledge of the history of the subject down to its latest continental developments, Sharpey was able to inspire his listeners with a profound and often lifelong interest in physiological science. The Germans trace the great upgrowth of physiology in their country during the middle and latter half of the nineteenth century to Johannes Müller, of Berlin. The English trace the subsequent great rise of physiology in their country directly to Sharpey. He trained the physiologists, *e.g.*, Sir Michael Foster, Sir John Burdon Sanderson, Sir Edward Sharpey-Schafer, who, by their own work, by the schools they founded and the pupils they in turn sent out, established English physiology, and (through Newell Martin, Foster's pupil, who went to Johns Hopkins) created American experimental biology. Sharpey's influence was not limited to the aspirants to a career in physiology. Men in other branches of medicine, like the surgeon Lister, even men in other walks of life altogether, were profoundly affected by his teaching. One of the proudest boasts of our own Dean Moyse, in whose honor this beautiful hall is named, was that when a student at University College he took Sharpey's lectures on physiology.

It was on Sharpey's advice that Lister, intent on the pursuit of surgery, proceeded to Edinburgh after receiving his London degree, in order to study under Syme. The story of Lister's rapid promotion there is known perhaps to most of us. What I wish to speak of this morning is the astonishingly original and important physiological work that he proceeded to carry out in Edinburgh before he was led to the final and greater discovery that has made his name live forever. When referring in his Huxley lecture of 1900 to this preliminary work, he speaks of it—not without a whimsical touch of regret—as being "probably little known to the present generation." One of the curious enigmas of scientific history is the slight attention that has hitherto been paid, even by professional physiologists, not to speak of his numerous clinical biographers, to the quality and importance of his investigations in pure physiology. Undertaken mainly in order that he might be able to speak to his students at first hand of the complicated processes involved, he had to make a strenuous effort simply to find the time for these wholly self-imposed researches. Much of the work was done with the help of his wife, in the back kitchen of the dwelling in Rutland Street in which they started housekeeping. When these early investigations, unexcelled in their experimental quality and in the depth of insight they display, have been properly appraised—and it is beyond the capacity of any one to do so in a brief memorial lecture—we shall be able to see Joseph Lister for the first time in his real greatness. Wide as was the range of these researches—they include the structure of plain muscle, the structure of nerve fibers, the flow of the lacteal fluid in the mesentery, nervous regulation of the arteries, function of the visceral nerves, inflammation, coagulation of the blood, the cutaneous pigmentary system of the frog—wide as was their range, hardly one of his conclusions requires alteration or amendment to-day. Some of his results that I might readily name still await exploitation, having remained untouched and undeveloped at the point where he then left them.

In order to give a conception of Lister's experimental power and insight, one might select at random

almost any aspect of these neglected researches and, by analysis of the contribution thus chosen, demonstrate the high place he achieved for himself in that particular field. I propose to adopt this method and to take his work on blood coagulation on the simple ground that I happen to be rather familiar with all its various antecedents, with its history up to the time of Lister, and after.

The problem of blood coagulation occupies a central position in medicine. It interests not only the physiologist and the pathologist but the practising physician, the surgeon, the obstetrician, and all in equal degree. Having extensive ramifications, it is also far from being a simple problem. In reporting on the question before the Royal Society of London in 1863 Lister says: "My difficulty on the present occasion does not depend so much on the lack of materials as on the complicated relations of the subject, which makes me almost despair of being able, in the short time that can be devoted to a lecture, to give, in anything like an intelligible form, even an adequate selection of the facts at my disposal."

When Lister came to the blood coagulation problem, the outstanding point of interest in the question was, "What induces the blood to clot when it comes out of the body? What first pulls the trigger, as it were, and sets in play the chain of events by which it inevitably changes from a fluid to a solid?" You may seek an answer to this apparently simple question in any of our modern text-books of physiology. Either the issue is avoided, or, if it is handled, you will be put off with carefully guarded answers, full of caveats and qualifications. The books are so anxious to describe the complex composition of the gunpowder that they forget about the percussion cap that is necessary to touch it off. We shall see with what result Lister worked at the question—but then, as I said, Lister's contribution to the subject is forgotten.

The problem, as presented to him, had taken scientific shape some ninety years before (between 1770 and 1776) at the hands of a brilliant investigator, William Hewson, whose untimely death at the age of thirty-six was a great loss to English physiology. Let us throw our minds backwards and picture the problem as it presented itself to the medical men of Hewson's time.

The blood comes out of the vessels. It is exposed to the *air*. What more simple than to suppose that the air acts on it?

Or, if you like, it *cools down*. We know that a solution of gelatine tends to set when it cools.

Again, the blood has come to a standstill. Whipped up in the circulation and kept in constant motion, one part gliding over another, it may have no opportunity, as it were, to stiffen. It might be that the simple condition of *rest* induces coagulation.

All these hypotheses—exposure to air, cooling, rest—had by one person or another been advanced as explanations. It was the merit of Hewson, along with other fundamental work on blood coagulation, first to devise and execute definite experiments to test these several hypotheses. He showed that cooling, instead of hastening, actually retards coagulation. He rapidly froze the blood, thawed it, froze it again, thawed it; it stayed fluid. He warmed it up; it clotted. A different matter this from any solution of gelatine.

In order to test the effect of rest, Hewson ligatured veins in two places, thus bringing the intervening column of blood to a standstill. Often enough no coagulation, but the results were variable and his conclusions indefinite. On the other hand, he could get no valid evidence that mere exposure of the blood to air has the slightest effect upon it. John Hunter made this matter still more definite. He received blood directly from a vessel into a Torricellian vacuum, where it clotted with particular prompitude.

Here was a difficult impasse. As no condition that one could reasonably think of seemed to be the cause, the London surgeon, Sir Astley Cooper, then made a new suggestion: "What if blood, wheresoever it be, has a natural tendency to clot? The impulse to coagulation may not be communicated by any external influence. It may be inherent in the blood, being constantly held in check by the vital action of the vessels." Cooper, as you see, simply inverted the issue. On his supposition there was no need to search for any new condition that acts upon the extravasated blood. What we require to explain—if the matter be susceptible of explanation at all—is not so much the fact of coagulation as the process by which the vessels succeed in keeping the blood fluid.

Sir Astley Cooper carried out no experiments. He merely promulgated a new idea. However, a young graduate who had studied under Cooper, by name Turner Thackrah, decided to take up the whole question afresh. Thackrah's important connection with the problem, like that of Lister, is little known to writers on blood coagulation. He was stimulated partly by his interest in the subject, partly by the fact that a valuable prize, the Sir Astley Cooper Prize, had been offered for the best essay on the subject of blood coagulation. In his consulting room at Leeds, where he had set up in practice, Thackrah worked away at his chosen problem. Fighting against tuberculosis, he died at the age of twenty-eight, but not before he had won the prize and left a memoir on blood coagulation which reveals that he was an experimentalist of a very high order. After his work

there could be no question of air, rest or cooling as causes of coagulation. In the end he was driven, one can see doubtfully and with no fervor of conviction, to the provisional conclusion that Astley Cooper's hypothesis best fitted the conflicting facts. Thackrah's essay was published in 1819.

In 1857 the subject set for the Astley Cooper Prize was again that of blood coagulation. Two essays were sent in, one by Dr. Richardson (later Sir Benjamin Ward Richardson, of public health fame), the other by Ernst von Brücke, professor of physiology in Vienna. The committee awarded the prize to Richardson, who advanced a new conception, viz., that the blood is kept fluid by a slight content of ammonia, the escape of which, when the blood is shed, allows the onset of coagulation. A somewhat analogous idea, involving, however, the gas carbon dioxide instead of ammonia, had been previously advocated with some apparent experimental support by Sir Charles Scudamore.

Brücke took his stand on Thackrah's work, which he greatly amplified and extended. In speaking of Thackrah's essay he says: "Surely no essay was ever more deserving of a prize." The final conclusion of Brücke, again hesitant, but adopted because he could see no other reasonable way out, was purposely phrased almost in Thackrah's own words: "The influence of the living heart and vessels is the source of the blood's fluidity, and its loss the cause of coagulation." Brücke's experimental findings, widely published and also incorporated in his own text-book of physiology, subsequently exercised much influence in Austria and in Germany.

At this stage, during the excitement of the Astley Cooper award, which caused rather an unusual flurry, enter Joseph Lister. He had read and studied Hewson and John Hunter: he had read Sir Charles Scudamore, Richardson and also Brücke. His first experiments were directed to an examination of Richardson's work, and it was some time before he was able to shake himself quite free of the ammonia theory. As usual, when he had to set aside an alluring and highly circumstantial hypothesis, he did so only after piling up overwhelming evidence against it. In order to preclude all escape of ammonia, a rubber tube, filled with a succession of short segments of glass tube, is looped and tied into a vein. The blood courses through. All the little glass sections are then separately ligated and the tube is removed. Confined in this way the blood clots just as quickly as when exposed to the air. Again, coagulation is known to be promoted when the blood is stirred with a rod. The stirring, according to Richardson, gives better opportunity for escape of ammonia. By means of an ingenious and complicated piece of apparatus Lister arranges to collect blood and to stir it without any possibility of ammonia escape. The mere stirring is found to accelerate coagulation. But I should weary you with those experiments on the ammonia hypothesis. Lister took much more than an hour to read his own paper. I have to be more brief.

Let us stop for a moment to picture him at work. As first assistant to Syme and later as full professor of surgery in Glasgow, he is subject to sudden call at any hour of the day or night. He has his own private patients. He has his lectures to prepare, constant infirmary duties, engagements of various kinds to keep. He must have gone from place to place, his mind constantly preoccupied with the particular research on hand; and we must also keep in mind the mere quantity of first-class physiological work that he turned out. The marvel is that he could find time to test his fructifying schemes and ideas. Fortunately, the slaughter-house is not far away. The veterinary college, where horses are killed, is also within easy walking distance. He goes to the slaughter-house, makes friends with the butchers. Sheep are being killed. He ties ligatures round their limbs, so as to cause venous congestion, and when the trotters are removed, he gathers them in his bag and hurries off to the back kitchen, where his wife has things ready for him. Or he learns that a horse is to be killed at the veterinary college. He goes there and secures the jugular veins filled with blood. Those who knew Lister tell us that his whole life was one endless succession of experiments. When later his attention was concentrated more upon wounds and upon dressings, he devoted infinite trouble to the selection of the best materials, trying and discarding scores of different things until he got the very best. He constantly went about with dressings and bandages on his own person. It may be news to some of the students of this audience that the introduction of all our routine surgical dressings—lint, gauze, absorbent wool, domet bandages, not to speak of the absorbable catgut to which he devoted so many years of patient labor—is due entirely to Lister's ceaseless experimentation.

Having disposed of the ammonia hypothesis, Lister next turned his attention to Brücke's conclusion that the influence of the living heart and vessels is the cause of the blood's fluidity. He set himself to devise some method of withdrawing it from this influence and, if possible, still keeping it fluid. The blood in the ligated vein of a horse stays fluid. Suspend the ligated vein, open it carefully and look down. The blood remains unchanged. Thanks to the work of the German physiologist, Henle, Lister knew that all the vessels have an inner lining of extremely deli-

cate flattened cells, which we now call endothelium. It might be possible to make cups of these large veins, and pour the blood from one to another through the air. He makes wire frames, sews the outer wall of the vein to these frames, turns down the top edge like a lip, and pours. In this passage through the air the blood is temporarily removed from the vital influence of the vessel—and he may go on pouring, alternately from one to the other—yet the blood does not clot. The evidence is still not conclusive, for the removal has been only temporary. The visceral cavity of the frog, with which blood does not ordinarily come in contact, is however lined with endothelium. He anesthetizes a frog, which is laid on its back; he opens the abdomen, pins the wall upwards and outwards, and makes a snip into the heart. The blood wells out into the endothelium-lined cavity. It does not clot. The same blood, pipetted out of the abdomen into a glass tube, coagulates. Plainly the issue narrows itself down to some difference between such a material as glass and endothelium.

Whenever coagulation had occurred one and the same condition had always been present. The blood had touched some foreign material.[2] He dips a solid rod into the fluid blood contained in an open vein. A crust of clot forms around the rod. He pushes needles into the veins of his sheep trotters; around the needle the blood coagulates, but not elsewhere. To make a long story short—and I can only refer you to his original paper for the wealth of detail and the ingenious variation of experiment by which he drives home the evidence—the cause of coagulation is neither more nor less than contact of the blood with extraneous foreign matter. The more effective the means taken to secure this contact, as by agitation or stirring, the more rapidly it clots. Here was some extraordinary influence, hard to explain on a physical basis, indubitably exerted by a mere touch with particular kinds of material. What this influence was he could only surmise. His training under Thomas Graham suggested some process of a catalytic nature. On the other hand, the absence of coagulation in the uninjured vessel shows merely that the endothelium is curiously and wholly neutral with regard to the process. It exerts no vital influence.

His next step was to demonstrate that the cells of the blood are implicated in the process, for in the absence of blood cells he could show that contact with foreign matter is powerless to cause coagulation. But at this critical and important stage he had to lay the matter aside. When he did return to it for a brief period in his later life, he proved that the influence which suffices to determine solid coagulation of the blood outside the body fails to act in the same way upon the circulating blood. The circulatory system contains some mechanism for protection against accidental intravascular coagulation. But I must not pursue the subsequent history of this fascinating subject. My object is to give some conception, however inadequate, of Lister's originality and amazing turn for experiment, in illustration of which I might equally well have selected almost any other of the physiological subjects that he handled at this commencing period of his career. Every touch of his work indicates the master hand.

Those of you who have visited Edinburgh may perhaps have wandered into the Library Hall of the old Arts Building of the university. There, close beside the octagonal table that Napoleon used at St. Helena, is another oblong table surmounted by a glass case containing the various distinctions and decorations that were eventually showered upon Lister by the world at large. Here are his medals; here the different orders conferred upon him by his own and by foreign countries; and here the beautiful casket that was presented to him when he was awarded the freedom of his native city of London. When at the end of his career he came to look back over the scenes of his struggles and of his hard-won victories, Lister decided that Edinburgh should be the repository of these unique tributes. There, under Syme, he had had his first full introduction to surgery; there he had courted and married Agnes Syme, the devoted companion of all his vicissitudes; there he had renounced his Quaker connection and joined the Church of England; from the University of Edinburgh had come William Sharpey and Wharton Jones, his London teachers; above all it was in Edinburgh that he had realized himself and learned to trust his own powers; there, experiencing all the alternating joy and disappointment, all the strong excitement of intensely interesting yet highly difficult scientific investigation, he had climbed those heights from which, without hesitation and with immediate comprehension he was in his turn to signal the beacon light that suddenly shone across from France. It is into his early struggles that a man puts, if not his best, at least his most significant effort; and just as Sir William Osler, looking back over his nomadic and meteoric career in three countries, decides that his ashes and his library, to the making of which he had devoted a lifetime, shall find a repository in McGill, where he had polished the weapons that carried him to his later triumphs, so did Lister feel that the scene of his scientific self-realization should retain those proud

[2] This suggestion, first mooted by Thackrah, had been more elaborately handled by Brücke, who finally, but not without qualification, discarded it.

insignia of homage that the nations had vied with each other in conferring upon him.

As time goes on, we shall come more and more to recognize in Lister an experimental genius of the first order. His trouble was that, being in every instance years in advance of his time, among men of lesser mould he was apt to be misunderstood. He had no gift of brilliant exposition by which he could rivet the attention of an indifferent public, and, with his innate modesty of nature, he had to rely for his ultimate vindication simply upon strenuous application to the work of his choice. The young assistants who loyally banded themselves around him, perceiving his merit, his sterling honesty to fact and the astonishing success of his methods, could guess at but could scarcely analyze his mental processes. They called him "a great thinker." They saw the outward Lister; they could not quite see what Wordsworth calls "the very pulse of the machine." There was, however, one experienced eye that had followed Lister's career from stage to stage with unabating interest. There was one man who could appreciate and closely follow every single experimental step he took. That was Sharpey. It was to Sharpey that the eager young student had first come with his microscope, seeking to examine for himself the structures of which the teacher spoke. It was Sharpey who had encouraged, advised and stood by him from the beginning, and before this inspiring and trusted counsellor died in 1880, he had the quiet satisfaction of knowing that his brilliant pupil had made what would probably prove to be one of the world's greatest discoveries.

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CHANNELS, VALLEYS AND INTERMONT DETRITAL PLAINS

AN article in the March number of the *American Journal of Science* by O. F. Evans on the "Origin of Certain Stream Valleys . . ." describes a common type of valley in the interior-plains region as having "a broad flood plain with a deep narrow trench winding through it." Is not this "trench" simply the river channel, filled to overflowing at time of flood, and occupied only by a dwindling, channel-bed stream during the rest of the year? In arid regions the prevailingly empty river channels, the beds of which are either dry or are followed only by the small flow of their low-water streams, contrast strongly with the well-filled river channels of humid regions, where a relatively constant flow covers all the channel bed and rises well on the channel banks. The most striking case of the arid-region kind that I have seen is in the interior of South Africa, where a channel over 100 feet in width at the rim and perhaps 30 or 40 feet in depth had, at the dry-season time of my visit, every appearance of a young valley, new-cut in a plain in consequence of river juvenation by uplift or otherwise, so deep was the channel bed below the surface of the plain and so small was the trickling stream that ran along the bed. Yet residents there assured me that, at time of great floods, the little stream expands until it fills the whole valley-like channel and overflows on the plain in which the channel is incised. Such a channel is truly trench-like; but it is nothing more than a channel after all. Its impressively large dimensions result simply enough from the great difference in volume of its river in low-water and in flood stages. Hence, unless the typical valleys described in the above-cited article are peculiar in some unspecified respect, it seems undesirable to adopt a new name, like trench, for their river channels. It would be unnecessarily redundant to have two names for one thing.

It is, on the other hand, true that we seem sometimes to have only one name for two geographical things, and there the poverty of our language in respect to appropriate names for the two features is embarrassing. For example, those lop-sided ridges which mark the outcrop of gently inclined, hard formations between more worn-down, weaker formations were long without any one-word name, until Hill of Texas introduced the Spanish word "cuesta" to designate them. They had previously been unsatisfactorily called "escarpments" by British geographers, who thus gave to the whole form the same name that is applied to one of its parts; namely, to the steep outcrop face of the determining hard formation, in contrast to the arched upland of the crest and the long and gentle declivity of the back slope. Cuesta is now coming to be more and more generally accepted as the technical, generic name for such forms.

But the poverty of our geographical terminology is sometimes rather apparent than real. Such is the case when a single name is used for two unlike features, although separate names are really available for them. Thus it is to-day customary in the Great Basin province to call the broad intermont detrital areas "valleys," as if the simple name, "plains," were not applicable to them and as if the equally simple name, "valleys," were not already fully enough employed in designating linear depressions, excavated under the guidance of streams or rivers, which are, like rivers, arranged in systems, with twig joining branch and branch joining trunk in down-grade suc-

cession. Unmindful of the earlier preemption of "valley" for forms of such erosional origin, that term is now taken over in the west to name broad and smooth surfaces of depositional origin.

For example, the extensive detrital plain in central Arizona, now redeemed from its original desert condition by irrigation from the waters of Salt River stored by the Roosevelt Dam in the mountains farther east and thereby converted into a superb oasis around Phoenix, the capital of the state, is universally called "Salt River Valley" by its prosperous residents. Yet the plain of the oasis seems level to the eye, except where rocky buttes of smaller or larger size rise through it, and it really has the form of a very broad and gently sloping alluvial fan. If the fan is crossed on a line transverse to its mid-rib, the surface is found to be faintly but characteristically convex. Its alluvial deposits are of great thickness; one of the many wells driven in them is 1,500 feet deep without reaching the solid rock of the depressed basin floor. The agricultural value of the apparently level irrigated area depends largely upon its possession of the regular and gentle, radially disposed slope that the fans of good-sized streams are necessarily given as they are built up; for in consequence of that slope, the construction of the canals which lead the stored-up water from the river, as it issues from the mountains, to all parts of the great oasis has not involved any great work of cutting or filling; and the fields into which the oasis is now subdivided are easily irrigated from the canals without regrading, by reason of their gentle slope.

As one drives over the plain, it seems geographically ludicrous to call it a "valley," yet there is no likelihood that the misnomer will be abandoned. Indeed the official map of Arizona shows that the name "valley" is repeatedly applied to the broad and desert intermont plains which occupy so large a share of its southwestern half. Further embarrassment arises from the fact that the plains are not infrequently traversed by valleys of small or moderate depth, which have been excavated in normal fashion by the intermittent rivers of the region; and these are unquestionably true erosional valleys, for they possess the four elements of form by which such valleys are known; namely, limiting side slopes, more or less frayed out by lateral wash; a smooth floor sometimes showing flat strips in faintly terraced arrangement, the lowest strip being the flood plain of to-day; a channel in the flood plain, usually dry but occasionally filled to overflowing; and a continuous down-stream slope. A fifth element of form, the reception of branch valleys at accordant level, is often added. The Gila, that long and slender tributary of the Colorado which crosses two states in a flow of irregularly increasing and decreasing volume, frequently follows shallow, gently terraced valleys of this kind, which it has slightly excavated in the broad intermont detrited plains; one such valley characterizes its course near certain isolated mountain ranges, some miles to the southwest of Phoenix, where the river has been driven by the fan of Salt River above mentioned.

On the other hand, the San Pedro, an affluent of the Gila which rises in the southeastern part of Arizona, has excavated a valley several hundred feet deep—one of the deepest of its kind in the state—in its northward course along the axis of a well-defined and heavily aggraded intermont trough. The width of this valley is much increased and its sides are much frayed out by many lateral wet-weather washes, as may be well seen from the main line and from the Douglas loop of the Southern Pacific railway, and from several state highways. In both these cases, the change from a former phase of aggradation to the present phase of excavation appears to be associated with the maturing of the Gila river system as a whole, but that is another story. Certain small and recent, but problematic changes in the channels of valleys of this kind have been lately discussed by K. Bryan. In view of the occurrence of these normal excavations, it is doubly unfortunate that the term, valley, is so generally used to designate not the excavations, but the intermont plains in which the excavations have been made. The proper term, plain, is thereby displaced from the aggraded surfaces which it names so well, and the term, valley, is misplaced from the erosional features to which it should be applied.

The numerous and extensive intermont detrital plains of the Great Basin province usually exhibit well-defined but gently inclined slopes of relatively coarse gravels, slanting forward from the base of the enclosing mountains and uniting in a broad, medial floor of finer soil and nearly level surface. The medial floor may or may not be incised by a true valley. When one stands on either detrital slope of such an intermont plain, an open view is afforded all across the medial floor to the opposite detrital slope; except that in plains of unusually great width, the opposite detrital slope may be lost in the distance. And from any part of the medial floor, which is everywhere lower than the detrital slopes that slant down to it, an open view is afforded of the gradual ascent by which the detrital slopes rise to the mountains. The slopes thus seen gain an appearance of exaggerated steepness by foreshortening. In the southeasternmost county of Arizona, the city of Douglas, where copper ore is smelted for Bisbee, a mining city that is crowded in a

steep-sided valley in the near-by mountains, has plenty of room for growth on a typical intermont detrital plain; but the plain is unfortunately known as Sulphur Springs Valley. Hence no generic name is left for the true though narrow and shallow valley that is excavated in the plain by the ephemeral wet-weather drainage which flows southward into Mexico. When one looks northward along the smooth medial floor of the plain, it seems to rise gradually to the skyline, as if in a distant ridge; but the ridge recedes as one travels towards it; it is simply the ocean-like horizon of the nearly level surface.

The intermont detrital plain on which the flourishing residential and university city of Tucson stands, not so near the southeastern corner of Arizona as Douglas by about 100 miles, occupies a well-aggraded intermont basin of depression, which departs in a peculiar manner from the typical form that is seen in the Sulphur Springs Plain. The detrital slopes that slant forward from the encircling mountains around Tucson are clearly enough seen when one is near them; but they are out of sight from a good part of the plain between them, which is not level but has a gently undulating surface, as if it had recently been warped. Its faint swells and hollows, well exhibited for several miles next north and east of Tucson, are clearly unlike the shallow valleys that have elsewhere been normally excavated a little below the surface of the plain by several small intermittent rivers. The undulations are frequently strong enough to hide a cross-plain view of the piedmont slopes; indeed, if one stands in the center of a faint hollow, the outward view, instead of being unobstructed for many miles as it should be on the medial floor of an undisturbed plain, is rather closely circumscribed in nearly all directions, as it should not be.

Some justification for attributing the faint swells and hollows of the Tucson plain to deformational warping is found in the southeastern part of the same intermont basin, where the detrital deposits are clearly seen to have been strongly tilted and elaborately dissected and degraded since their deposition. The plain in the neighborhood of Tucson must have been deformed at a later date than this dissected southeastern extension of the intermont area, for it is practically undissected, except along the margins of its normal valleys. Another indication of warping is found in the present course of the Rillito, a wet-weather stream that flows westward across the aggraded basin not far north of Tucson and but a few miles south of the Santa Catalina Mountains, the highest of the enclosing ranges. The stream ought to have been pushed much farther away from these mountains by the abundant outwash of detritus that their deep-cut, steep-sided valleys have supplied to the intermont area; but the deformational warping appears to have compelled the stream to shift northward toward the mountains, in spite of the detrital outwash from them. In consequence of that shift, the piedmont detrital slope is sharply undercut by the northward encroachment of the stream upon it, and its dissection by washes from the mountains is thus promoted to an exceptional degree. The deformation of the plain seems, indeed, to have extended beyond the west-flowing Rillito, for between its contrained course and the base of the mountains, the detrital slope has assumed various irregular forms with a relief of 200 or 300 feet. Yet 20 or 30 miles farther west, the intermont plain has a strikingly level surface and so continues much farther, as if it were there in process of undisturbed aggradation.

There is, as above noted, little likelihood that the people of Arizona will change the nomenclature that has been so unsystematically applied to the intermont detrital plains on which many of them live; but for geographical purposes it is eminently desirable to call the plains by their proper name, and to recognize their subdivision into piedmont slopes and medial floors, as well as the not infrequent excavation of true valleys across them; and to recognize also the warping by which at least one of them seems to be gently deformed.

W. M. Davis

Harvard University

SCIENTIFIC EVENTS

THE ELEVENTH EXPOSITION OF CHEMICAL INDUSTRIES[1]

When the doors of the Eleventh Exposition of Chemical Industries are opened on September 26, those who will avail themselves of the opportunity will be impressed by the large number of diverse exhibits which will show something of the tremendous advancement that has been made, thanks to the continued application of science in cooperation with sound finance. Some 350 exhibitors will display a wide range of chemicals, chemical products and the apparatus, equipment and scientific instruments used in producing them, as well as many of the required raw materials.

The exhibits will be chiefly from this country, but there will be many representatives of foreign activities. The raw materials to be shown are from the Southern, the Southwestern and the Pacific States, and from the Dominion of Canada, displayed by government departments and railroads concerned with the industrial development of their territory. The section of chemical and chemical product exhibits is three times as numerous as five years ago. The machinery

[1] *Industrial and Engineering Chemistry.*

exhibit has increased in number and variety. The instruments exhibits will show marked strides in accuracy, application, simplicity and usefulness. In addition, there are sections devoted to laboratory supplies and equipment; to containers, packaging, labeling and shipping; to plastic compositions; to transportation, and to material handling.

Statistics of the sections specializing in laboratory equipment and supplies will give an impression of the scope of the present exposition, the number indicating the units in this section: laboratory furniture, 7; general laboratory apparatus and supplies, 7; special equipment, 13; balances, 3; research chemicals, 9; platinum ware, 3; glass, porcelain and silica ware, 9; filter-paper, 3; optical instruments, 3; electrical apparatus, 3; thermal precision instruments, 6; engineering equipment, 13, and publishers, 9.

The United States Government has prepared exhibits showing the work of three of its principal departments. The War Department will be represented by an exhibit from Chemical Warfare Service. The Department of Commerce will be represented by the Bureaus of the Census, Mines, Standards and Foreign and Domestic Commerce and the Committee on Wood Utilization; the Department of Agriculture by the Bureaus of Chemistry and Soils, including the Fixed Nitrogen Research Laboratory, Animal Industry, Forest Service and others. The National Safety Council will present, in complete form, the recently concluded exhaustive study on hazards caused by benzene when used in products designed for manufacturing and domestic use. There will be other educational exhibits and booths arranged by scientific societies, prominent among which will be that of the American Chemical Society.

The educational features of the exposition include an excellent program of motion pictures, the students' courses and meetings of certain scientific societies. The students' courses—a unique feature of this exposition—have become established and will be attended by representatives of many educational institutions of this and other countries.

The Fifth Chemical Industries Banquet will be held during the exposition on Wednesday evening, September 28, under the auspices of the Salesmen's Association of the American Chemical Industry, sponsored by the American Ceramic Society, New Jersey and New York Sections of the American Chemical Society, New York Section of the American Electrochemical Society, Chemical Warfare Association, Chemists' Club, Pressed Gas Manufacturers' Association, Chlorine Institute, American Institute of Chemical Engineers, American Leather Chemists' Association, Manufacturing Chemists Association, Société de Chimie Industrielle, Society of Chemical Industry, American Society for Testing Materials, American Association of Textile Chemists and Colorists, Synthetic Organic Chemical Manufacturers' Association and the Technical Association of the Pulp and Paper Industry, at the Hotel Roosevelt.

THE KANSAS GEOLOGICAL FIELD CONFERENCE

The annual field conference of the Kansas Geological Society was held in northeastern Missouri, eastern Iowa and adjacent parts of Illinois and Wisconsin, from September 5 to September 10. About forty geologists participated. The object of the conference was to study the outcrops on the surface of the lower Paleozoic rocks, especially the Ordovician and the Mississippian, in the regions visited.

The party assembled at Columbia, Missouri, and on the morning of the fifth, started out under the direction of Professor E. B. Branson, of the department of geology of the University of Missouri. For three days studies were made along the bluffs of the Missouri and Mississippi Rivers and their tributaries, in northeastern Missouri, night stops being made at St. Louis and Hannibal.

At Burlington, Iowa, the party was joined by Dr. George F. Kay, state geologist of Iowa, with his assistants, and for three days Dr. Kay, Dr. O. A. Thomas and G. Marshall Kay conducted the party through eastern Iowa and adjacent parts of Illinois and Wisconsin.

The chief object of the trip was to correlate the various exposures which occur in northeastern Missouri and eastern Iowa with various formations encountered by deep drilling in central Kansas and northern Oklahoma. The oil-bearing sand, which in these latter states is known as the Wilcox sand, and which is the chief producer in a number of Oklahoma and Kansas oil wells, is believed to be the approximate equivalent of the St. Peter sandstone, of the states visited. The Decorah shales which contain certain typical fossils and are easily recognized in many of the deep wells in Kansas, was first named more than fifty years ago at Decorah in northeastern Iowa.

One of the principal points brought out on this conference is the intimate relation between pure science and practical affairs. Twenty years ago, or even five years ago, geologists would not have thought of traveling hundreds of miles to study outcrops of fossil-bearing rocks, in order to understand and interpret well logs in distant states.

The personnel of the party consisted of State Geologists Kay, of Iowa, Condra, of Nebraska, Moore, of Kansas, and Gould, of Oklahoma; also Professors

Dunbar, of Yale, R. T. Chamberlin, of Chicago, Branson and Mehl, of Missouri, and Bridge, of the Missouri School of Mines. In addition there were more than twenty petroleum geologists from Kansas and Oklahoma. To L. W. Kesler, of Wichita, president of the Kansas Geological Society, is due much of the credit for the success of the conference.

THE COMMITTEE ON SEISMOLOGY OF THE BRITISH ASSOCIATION

For thirty-one years a committee appointed by the British Association has published an annual report on seismological investigation. Under the chairmanship of Professor H. H. Turner, it works in close association with an international body which with financial help from the Royal Society is trying to bring up to date summaries of the observed details of earthquakes all over the world. Summaries up to the end of 1923 have been issued, and those for the greater part of 1924 are well in hand. From these exact knowledge of the transmission of earthquake shocks is gradually being obtained, and the existence of anomalous cases is being verified.

When it happens that there are a number of good recording stations reasonably near the center of an earthquake, special information can be derived from their records as to the nature of the upper layers of the earth's crust. The Jersey and Hereford earthquakes of 1926 yielded specially useful results in that respect. British earthquakes have been rare, but in August, 1926, there was one at Hereford and Ludlow, on January 24, 1927, one in Scotland and on February 17 last one in Jersey. Yorkshire appears to have had an earthquake at Tadcaster on a recent evening, but seismological apparatus is not of a kind that can be carried about, and the members of the committee in their report to the section were reticent as to this manifestation.

The committee reported that the Palestine earthquake of July 11, although serious and causing much local injury and many deaths, was not of unusual violence. The intensity of its indications on the Oxford seismograms was much less than in the case of the earthquake in China on May 22, although the latter was at a much greater distance.

The University of Oxford has sanctioned the extension of the university observatory to provide a home for two Milne-Shaw pendulums, and a bequest of £1,000 from the late Professor John Milne, one of the chief founders of seismology, has been put in a trust fund, the income to be at the disposal of the chairman for the time being of the seismological committee of the British Association.

THE NATIONAL ARBORETUM

Plans for the establishment of the National Arboretum, authorized by the last congress, have been discussed, according to *The Museum News,* at informal meetings of the newly appointed advisory council. With the probability that an appropriation for the purchase of land will be passed at the next session, along with the deficiency bill, of which it forms a part, various phases of the project are now receiving consideration.

The Department of Agriculture has estimated that about a year will be necessary, in which to acquire land, before the actual laying out of the grounds can begin. In the plans already discussed, emphasis has been laid upon the research features, which are to be somewhat subordinated to recreational aspects.

The site, which has been tentatively selected, lies upon the Anacostia River, within four miles of the center of Washington. Part of the land is now under government ownership, and is being reclaimed from its original swamp condition. The location of the arboretum at this point means that eventually it will lie along or near the proposed new parkway entrance to the city. A new boulevard, which will connect Washington with the northern and eastern cities will, at some future time, be opened up along the Anacostia valley, in which the arboretum site is also located.

It is pointed out by officials of the Department of Agriculture that the selection of Washington for the site of an arboretum will secure an average climatic condition about midway between that of the extreme northern states and those along the southern border. They also predict that there will be very close cooperation between the various institutional herbaria, city and state botanical gardens and the various propagating stations operated by the federal government in California, Florida, Georgia, Maryland and other states. The work of introducing foreign plants will be greatly facilitated thereby and the agricultural explorations of the government will also assist in the building up of the herbarium.

BIOLOGY AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

The trustees of the California Institute of Technology have voted to establish a department of biology and to erect at once biological laboratories; so that the institute may, in the autumn of 1928, initiate major lines of research and offer courses of study, both graduate and undergraduate, in that science. Professor Thomas H. Morgan, now professor of experimental zoology at Columbia University, has accepted the position of chairman of the new divi-

sion of biology, and will organize its various branches. Ample funds have been provided for the endowment, construction and equipment of the laboratories by members of the Board of Trustees of the institute and by the General Education Board.

As in the existing departments of the institute, emphasis will be placed primarily on research and graduate study; and, even in these directions, no attempt will be made to cover at once the whole science of biology, but rather, efforts will be concentrated on the development of those of its branches which seem to offer the greatest promise as fields of research. As rapidly as leaders can be found, it is proposed to organize groups of investigators in general physiology, genetics, biophysics, biochemistry, developmental mechanics, and perhaps later experimental psychology. The choice of these fields of modern research implies that emphasis will be laid on the intimate relations of biology to the physical sciences. That a closer association of these sciences with biology is imperative is becoming more and more apparent as indicated by the development of special institutes for such work. In England, Germany, Russia, Scandinavia and France research institutes, specializing in different biological fields, yet primarily concerned with the applications of mathematical, physical and chemical methods to biological subjects, have developed in recent years. The latest example is a gift of thirty million francs to the Paris Academy of Sciences to organize an Institute of Physico-Chemical Biology, for the purpose of studying "the physico-chemical mechanism of the phenomena of life."

The California Institute is undertaking this development of biological research by the application of physical and chemical methods not only because of its intrinsic importance, but also because the close association with the strong research departments of physics and physical chemistry of the institute can not fail to contribute greatly to its success. Most physiological laboratories have in the past, for practical reasons, been associated with medical schools; and few of them have been in intimate contact with the research staffs and had the use of the research facilities of laboratories which are primarily devoted to fundamental investigations in the physical sciences.

For the study of biology the institute will in 1928 and thereafter make the following provision. It will introduce into its four-year undergraduate course in science, which in its last two years now has options in physics, chemistry, mathematics and geology, a new option in biology. This option will include those fundamental biological subjects that are an essential preparation for work in any special field of pure or applied biology; and the four-year course as a whole will in addition afford a far more thorough training in the basic sciences of physics, chemistry and mathematics than students of biology, medicine or agriculture commonly receive. This undergraduate course will be supplemented by a fifth-year course, leading to the degree of master of science in biology, in which students may specialize in study and research in various branches of the science. Special opportunities will also be offered for the pursuit of more advanced courses and extended researches leading to the degree of doctor of philosophy, to students desiring to become college teachers, research men, or professional experts.

SCIENTIFIC NOTES AND NEWS

Sir Charles Scott Sherrington, O.M., professor of physiology at the University of Oxford, will give three lectures under the Edward K. Dunham Lectureship for the Promotion of Medical Research in the Amphitheater of the Harvard Medical School at five o'clock on Monday, October 10, on "Observations on Stretch Reflexes"; Thursday, October 13, on "Modes of Interaction between Reflexes," and Monday, October 17, on "Some Factors of Coordination in Muscular Acts."

The faculty of the Medical School of the University of Wisconsin gave a dinner recently at the Maple Bluff Country Club in honor of Dr. Aristides Agramonte, professor of bacteriology, University of Havana, and Dr. Salanos Ramos, dean of the medical school of that university, which was attended by about sixty-four physicians, President Glenn Frank, of the University of Wisconsin, and members of several faculties. Dr. Charles R. Bardeen, dean and professor of anatomy, was toastmaster; Dr. Frank welcomed the visitors, who are on a tour of inspection of medical schools, and Dr. Agramonte spoke of health work in Cuba and the development of the medical school of the University of Havana, which was founded in 1728.

Professor H. E. Armstrong, the distinguished British chemist, and Mrs. Armstrong celebrated their golden wedding on August 30, on which occasion there was presented to them a portrait of Professor Armstrong by T. C. Dugdale. At the same time there was presented an illuminated album, signed by a large number of workers in chemical science.

F. C. Elford, of the U. S. Department of Agriculture, has been elected president of the World's Poultry Congress, the fourth meeting of which will be held in England in 1930.

Dr. Karl Siek, professor of surgery in the University of Hamburg, has been appointed honorary

professor by the University of Göttingen in recognition of his services in organizing medical education in Turkey.

Dr. Guy W. Clark, since 1919 assistant professor of pharmacology in the University of California Medical School at Berkeley, has resigned to become director of the pharmaceutical department of the Lederle Antitoxin Laboratories.

Frank C. Whitmore, head of the department of chemistry at Northwestern University, is on sabbatical leave to serve in Washington as chairman of the Division of Chemistry and Chemical Technology of the National Research Council.

In the absence from this country of Dr. C. E. McClung, professor of zoology in the University of Pennsylvania, managing editor of *The Journal of Morphology and Physiology,* contributors are requested to send their manuscripts directly to the Wistar Institute, 36th Street and Woodland Avenue, Philadelphia, Pa. Dr. McClung expects to spend some months at the Naples Station.

Dr. Chas. L. Swisher, professor of physics at the North Dakota State College, has been granted a leave of absence by that institution in order to permit him to accept an assistant professorship in physics at Yale University for the coming year.

Dr. Fred F. McKenzie, instructor and assistant in animal husbandry in the Experiment Station of the University of Missouri, has resigned to accept a position as director of the College of Agriculture at the International College, Smyrna, Turkey.

Philip L. Riley, instructor in the department of biology and public health at Massachusetts Institute of Technology, has been appointed director of health education in the public schools of Cleveland, Ohio.

Frederick H. Rawson has been elected a member of the board of trustees of the Field Columbian Museum. Mr. Rawson, who is chairman of the board of directors of the Union Trust Company of Chicago, has been actively interested in the work of the museum for years as life member, corporate member and patron.

The Committee on Scientific Research of the American Medical Association has recently voted to Dr. Edward Reynolds and Dr. Earnest A. Hooton, of Harvard University, a grant of $1,000 for a research on the mechanism of the erect posture by X-ray study of the living in the erect position.

Dr. R. Hugershoff, of Dresden, gave on September 16 an illustrated lecture and demonstration on the "Aerocartograph," a new process of making contour maps from aerial photographs, before members of the U. S. Geological Survey and other federal mapping agencies.

Dr. Joseph Jastrow, formerly professor of psychology in the University of Wisconsin, will this autumn give a series of lectures on "The Psychology of the Emotions," under the joint auspices of the New School for Social Research and the Child Study Association of America.

Miss Ida M. Mellen, assistant to the director of the New York City Aquarium, will broadcast a series of seventeen talks from WNYC, beginning with a talk on "The New York Aquarium and its Denizens," on November 6, at 9 p. m. Eleven talks on fishes will follow, other subjects being whales, seals, sea birds, alligators and turtles.

Professor Geo. T. Hargitt has presented to the library of the Marine Biological Laboratory that part of the late Charles W. Hargitt's library that contains the literature on Coelenterates. The gift comprises a collection of the literature of the group that could be gathered together in no way so completely as that of selection by such a specialist as Dr. Hargitt. A memorial tablet will be placed on the wall of the library stack-rooms to commemorate Dr. Hargitt's life and work and his connection with the laboratory. The libraries of Glendower Evans, C. O. Whitman, Edward G. Gardiner and many others have also in part, or in whole, been deposited in the library.

At the Leeds meeting of the British Association it was announced that the council was supporting a movement to purchase Charles Darwin's home and estate at Downe.

It is proposed by Germans resident in Brazil to erect a memorial to the naturalist Fritz Müller in Blumenau, where he spent the greater part of his life.

The municipal council of Paris has approved the erection of a statue to the physician and physiologist Vulpian, whose researches on the nerves and vasomotor phenomena are well known. The statue, the work of the sculptor Paul Richer, member of the institute, will be placed near the Faculté de médecine.

The death is announced on January 14 of Sarah Frances Whiting, from 1876 to 1912 professor of physics and physical astronomy and from 1904 to 1916 director of the Whitin Observatory, becoming on her retirement director emeritus. Miss Whiting was eighty-one years old.

Frank Clinton Wright, editor of *The Engineering News Record,* died on September 18, aged forty-six years.

Dr. Mabel M. Brown, assistant professor of botany in the University of New Hampshire, died on September 16.

Henry Richardson Procter, professor at the University of Leeds and later honorary director of the research laboratory for the leather industry established in that university, died on August 17 at the age of seventy-nine years.

Professor C. Pullfrich, of the Zeiss Optical Works at Jena, known for his investigations in optics, has died at the age of sixty-nine years.

As has been noted in Science, the fall meeting of the National Academy of Sciences will be held at Urbana, Illinois, at the University of Illinois, beginning on Tuesday, October 18. This is a departure from the usual custom of holding the meeting in November and beginning on Monday. Dr. A. L. Day, of the Geophysical Laboratory of the Carnegie Institution, will give an illustrated evening lecture on October 18 on "The Volcano Problem." The executive committee of the American Association for the Advancement of Science is to hold its October meeting in Urbana on October 16. The state geologists of the country are to assemble in Urbana on October 20 for a three days' field trip under the direction of the geologists of Illinois.

The fifty-sixth annual meeting of the American Public Health Association will be held, under the presidency of Dr. Charles V. Chapin, at Hotel Gibson, Cincinnati, Ohio, from October 17 to 21.

The American Society of Tropical Medicine will hold its twenty-third annual meeting in Boston, from October 21 to 22, under the presidency of Dr. George C. Shattuck, assistant professor of tropical medicine, Harvard University Medical School, Boston.

The twenty-first annual convention of the Illuminating Engineering Society will be held in the Edgewater Beach Hotel, Chicago, from the eleventh to the fourteenth of October.

The fourteenth annual meeting of the New England Section of the American Society of Agronomy will be held at Boston on December 2 and 3. Symposia on "Land Utilization Programs and Fertilizer Requirements of Specific Crops" will be held.

The U. S. Civil Service Commission announces an examination for the position of technical editor for vacancies in the forest service at Washington and at the Forest Products Laboratory at Madison, Wis. The entrance salary is $3,800 a year.

The *Journal* of the American Medical Association states that the state department has advised the U. S. Public Health Service that the Egyptian legation in Washington desires brought to the attention of qualified American citizens the fact that the Egyptian government wants to employ a foreign specialist in medical entomology in the ancylostoma and bilharzia research section of the public health laboratories of the Egyptian government.

UNIVERSITY AND EDUCATIONAL NOTES

The General Assembly of Georgia just adjourned appropriated $1,000,000 per year for each of the years 1928 and 1929 to be used to equalize educational opportunities. This revenue is to be derived from a one half cent tax on each gallon of gasoline and a tax of one cent on each gallon of kerosene. If the revenue from these two taxes does not yield a million dollars the balance will be supplied out of the general treasury. All revenue from these two taxes will be used as an equalization fund, even though it should exceed one million dollars.

Isaac E. Emerson, chairman of the board of the Emerson Drug Company, has given two fellowships to the University of Maryland. One is for a professorship in biological testing yielding $4,000 annually; the other, yielding $1,500, is to maintain a fellow in pharmacology in the School of Medicine.

Sir Edward Brotherton, the chemical manufacturer, of Leeds, who has works in Leeds, Liverpool and other parts of the country, has made a gift of £100,000 for a new library for Leeds University.

Dr. S. W. Ranson, professor of neuroanatomy at Washington University, St. Louis, has been appointed professor of neurology and director of a Neurological Research Institute at Northwestern University Medical School. Quarters for the new institute have been provided in the Ward Memorial Building, which was erected last year on the McKinlock campus. The institute will be devoted entirely to research and will conduct investigations in the anatomy, physiology and pathology of the nervous system and in clinical neurology and neurosurgery. Dr. Lewis J. Pollock, professor of neurology, and Dr. Loyal E. Davis, associate professor of surgery, will cooperate with Dr. Ranson. An assistant professor of neuropathology and an assistant professor of anatomical neurology as well as younger men with training in physiology and biochemistry will be appointed. Problems connected with the innervation and nervous control of the skeletal muscles will be among the first with which the institute will deal.

Dr. J. C. Hubbard, head of the department of physics at New York University, has been appointed professor of physics at the Johns Hopkins University.

Dr. William Mansfield Clark, Ph.D., of the Hygienic Laboratory of the U. S. Public Health Service, Washington, has accepted the position of professor of physiological chemistry at the Johns Hopkins University School of Medicine.

Quentin D. Singewald, Ph.D. (Johns Hopkins, '26), has been appointed to an assistant professorship of petrography in the Colorado School of Mines, at Golden.

Dr. Peter Debye, professor of physics in the Technical School of Zurich, has accepted a call to the University of Leipzig, where he will succeed Professor Otto Wiener.

DISCUSSION AND CORRESPONDENCE

AN ECHO FROM MORRISON CHAPEL, TRANSYLVANIA UNIVERSITY

The description of the echoes from the Lincoln Memorial by C. A. Browne in Science, July 29, 1927, calls to mind an interesting echo produced by Morrison Chapel of Transylvania University. The sound comes from the bell of the Court House clock, several blocks away. The echo was first noticed one evening several weeks ago when the writer was sitting in a

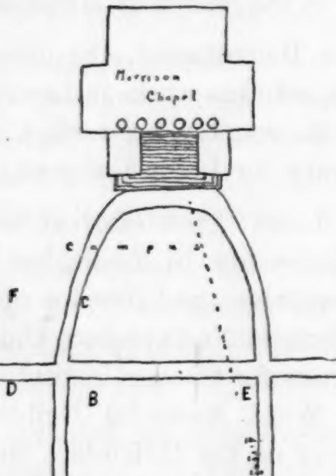

Fig. 1

park adjacent to Transylvania campus. It so happened that the position taken was such that the echo gave the impression of the clock striking twice as rapidly as usual, and, of course, a double number of strokes. The echo seemed slightly higher pitched than the clock bell. This first position is indicated as point A. Subsequent observations from various points in the park and campus are as follows: From points B, C and D the echo follows the bell so closely as to sound like a double stroke rather than a double number of strokes, and at E and F the echo was not heard.

William A. Anderson, Jr.

Kentucky Agricultural Experiment Station, Lexington

ICARUS AND MELTING WAX

In Professor Eddington's fascinating book "The Internal Constitution of the Stars," we are given the privilege of watching the "hurly-burly of atoms, electrons and ether-waves" in stellar interiors. Our astronomer pictures the commotion prevailing in these tremendous gas-houses, as atoms go whizzing by, now and then shedding an electron and anon grabbing some stray one, the whole result of the bustle being the emission of ether-waves. No humble earthworm can say aught to the contrary; but he may balk in following the astronomer in flights through the earth's atmosphere.

"In ancient days," he says, "two aviators procured to themselves wings. Daedalus flew safely through the middle air and was duly honored on landing. Icarus soared upward to the sun till the wax melted which bound his wings and his flight ended in fiasco. . . . The classical authorities tell us that he was only doing a stunt, but I prefer to think of him as the man who brought to light a serious constructional defect in the flying machines of his day."

These pioneer airmen were father and son. And the question naturally arises "Was not father in equally great danger?" His wax attachments were exposed to the full radiation from the earth. Icarus, poor boy, flying higher and higher had to go through the troposphere. And as he rose from earth it got colder and colder. Even in a genial clime on a midsummer day, by the time he was five miles high, he would have been frozen stiff. With a temperature of $-40°$ C. the very mercury in his thermometer would have solidified. If he lived to reach the stratosphere he still had to fly a hundred miles in cold storage!

And why decry old Daedalus? If it was necessary to find the melting-point of wax, the experiment could have been carried on just as well down below.

My good friend Dr. W. W. Campbell used to say "This would be a happy world for astronomers if only there were no atmosphere!"

Alexander McAdie

Blue Hill Observatory

HORTUS GRAMINEUS WOBURNENSIS

The undersigned would like to be advised of the location of an 1816 edition of George Sinclair's Hortus Gramineus Woburnensis. The copy in the Library of the United States Department of Agriculture gives on page 108 a description of *Trifolium medium*, a red perennial clover, and the author states that to avoid any chance of mistake he presents a specimen of

the red perennial clover, and on page 109 a dried specimen of *Trifolium pratense* is presented. The undersigned has been unable to locate any other copy of the 1816 edition and wishes to do so in order to ascertain whether this error is found in all copies or is peculiar to this one copy and will appreciate any information as to libraries where other copies may be consulted.

A. J. Pieters

Bureau of Plant Industry

QUOTATIONS

THE WORLD POULTRY CONGRESS

Although from a spectacular standpoint the recent Poultry Congress at Ottawa was an unqualified success, in consequence of which the poultry industry in Canada will derive considerable benefit, it is difficult at present to form an estimate of the educational value of the proceedings and to assess the importance of the information derived from the numerous papers and discussions. There would appear to be some justification for critical comment upon the fact that papers were not printed in advance, so that, as five sections were in session at the same time in different halls, delegates experienced great difficulty in gaining more than a vague impression of the whole, while the general public must await the publication of the official proceedings before it will be possible to summarize the educational effect of the congress.

The general impression, which is confirmed by the evidence of delegates, is that insufficient time was available to do justice to the many papers presented by authorities in the numerous branches of the industry. Not only did the "five-ring circus," as an American delegate described it, create confusion among those who were desirous of getting full educational value, but the absence of printed papers and the short time allowed for each paper necessarily limited the scope and the value of such discussion as was permitted. In view of the fact that the next congress is to be held in England in 1930 it will be necessary to formulate a policy that will do justice to the educational side, though it may be impossible to emulate the generous manner in which the Canadian government gave the poultry industry the best publicity it has ever enjoyed. The fortunate circumstance which enabled the Prince of Wales and Mr. Baldwin to visit the congress set the seal upon the efforts of the Canadian authorities to make the event a thorough success in the spectacular sense.

It is the more regrettable, therefore, that doubt exists as to whether the original purpose of world's poultry congresses was sufficiently considered. The International Association of Poultry Investigators and Instructors inaugurated these triennial congresses with a view to enabling research workers and educationists to express their views and discuss experiences; and one suspects that interest in the Canadian congress spread so widely that the authorities found themselves with a plethora of good things which could only be embraced in the program by the quintuple-session plan. Even that would have been effective had the papers been printed in readiness for the proceedings, and it seems essential that that precaution should be taken at future congresses unless a drastic measure of compression is adopted by limiting the number of papers.

A further point which must be borne in mind for future congresses arises from apparent differences between investigators and practical poultrymen. It is conceivable that some of the former approach the task of research from the laboratory standpoint, whereas some practical men are so exacting as to demand that all investigation shall begin and end in the poultry yard. Doubtless there is a measure of reason on both sides, and a considerable amount of latitude must be allowed. It can not be denied, however, that research is a means to practical progress, and in connection with poultry-keeping its success must be measured by what it achieves in smoothing the path of the practical worker. That in turn depends upon close association and mutual confidence between the two classes, so that every effort should be made to interest scientific investigators in the every-day problems of the practical poultrymen at the same time as the latter are induced to take research workers into their confidence.—*The London Times.*

SCIENTIFIC BOOKS

Elements of Physical Biology. By Alfred J. Lotka. Baltimore, Williams and Wilkins Co., 1925. xxx + pp. 460.

Once in a while some one writes a really new book such as "The Fitness of the Environment," "Winnie the Pooh," "Die Ausdehnungslehre" or "Oedipus Tyrannus." Sometimes such works are immediately approved like the first two; sometimes, as was the case with the third, not even the brightest minds of the time seem to appreciate the significance of the book and a generation or two elapses before the author comes into his own. With respect to the last, it was crowned at once with approval but perhaps not understood until the advent of psychoanalysis millenniums later, although to one who knows his Greek drama not quite so poorly as his psychoanalysis it sometimes seems as though the complex that afflicted Oedipus was the opposite of the Oedipus complex! Lotka's "Physical Biology" is a new, not merely a

recent, book; whether it will go promptly with our effective scientific literature may be doubted; it is not easily read by most biologists who, rather than mathematicians or physicists, must make it effective. Like many really new works it contains a great deal of the author's thinking and writing for a good many years. The fundamental idea is simple, namely, that the rates of change of certain variables x_1, x_2, . . . x_n are functions of the variables themselves and of certain parameters P_1, P_2, . . . P_m, that there will be an equilibrium situation (with respect to the time) for those values of the variables which make the rates of change zero, albeit this equilibrium situation may change with changing values of the parameters, and that if the variables differ only slightly from their equilibrium values there will occur a variation of those variables in time. Primarily it is the study of this well-known system of equations that concerns the author and the interpretation of the results when the variables and parameters represent quantities of biological significance.

The simplest case is the law of population growth, $dX/dt = F(X)$, it being assumed that the rate of that growth depends solely on the population. Here there will be equilibrium for those values of X which make $F(X) = 0$, *i.e.*, the population can maintain itself at any value X_0 such that $F(X_0) = 0$ because then $dX/dt = 0$ and there is no rate of change of population. One solution is $X_0 = 0$. If X is near zero we may expand F(X) by Maclaurin's series to a single term and have $dX/dt = aX$, which gives the Malthusian law of growth. Evidently, too, the population may be saturated at a value X_0 different from zero. In the neighborhood of this value we may expand by Taylor's series to find $dX/dt = a(X-X_0)$, where for stability a is necessarily negative, and asymptotic approach to the equilibrium value from above or from below. If we consider the two roots 0 and X_0 we may write $dX/dt = aX(X_0 - X)\varphi(X)$, and by neglecting φ (X), *i.e.*, by assuming it does not vary appreciably between 0 and X_0, we have the Verhulst-Pearl-Reed law of population growth—a law which the author shows does not hold for the growth of the rate in weight (Donaldson). By considering two variables in a similar manner one may discuss the interrelation of two populations, symbiosis, immunizing diseases, malaria-like diseases, parasitism, etc. Or by the further analysis of the growth function of a single variable one may derive certain demographic relations and conceptions which have been introduced by the author and used by him as a means of research on human populations.

From this brief discussion I intend to imply what I believe to be a characteristic of the book, namely, that it is fundamentally mathematical rather than physical biology, that it portrays the workings of a mind more mathematical than physical. Certainly physical biology should include a great deal about the theory of dimensions, about surface tension, etc., indeed much of the point of view and of the sort of material which may be found in d'Arcy Thompson's "Growth and Form." There seems to be in the book almost none of the sort of thinking that a physicist does. I do not particularly object to the author's choice of a name for his book; it is all right if you understand it; I am merely trying to point out that what some might expect to find under the name is conspicuous by its absence. Gibbs did not call his great work physical chemistry, and if he had, a contemporaneous reviewer might have made observations not dissimilar to mine above. And, by the way, although Lotka undoubtedly knows his Gibbs, even the "Statistical Mechanics," and often gives a type of reasoning very familiar to students of Gibbs, there happens to be no mention of that great name in the Index of Names which appears to list more than 400 persons as cited in the text. And again, by the way, if one will look at that list of names and examine the text to see how intimately ideas from very many of them are interwoven to carry forward the author's own thought, one can not but realize the long time and deep study and varied reading required to bring oneself to a position where he could contemplate writing such a book.

Although the main underlying thought may be mathematical, there is much general philosophy of science and much general descriptive material to be found in this work, much that is as easy to read as it is interesting and instructive, not a little perhaps which is of no great importance to the work as a whole. The author knows how to write, not only in detail but in a broad way, how to lighten heavy reading with description, to intersperse chapters weighty in mathematical formulas with those entirely free of them. And what a mass and variety of material he has thus put together! It would be quite out of the question for a single reviewer either to do it justice or to point out whatever defects of judgment it may contain.

Edwin B. Wilson

SPECIAL ARTICLES

THE ANTI-COAGULATING ACTION OF THE SECRETION OF THE BUCCAL GLANDS OF THE LAMPREYS (PETROMYZON, LAMPETRA AND ENTOSPHENUS)

The function of the paired buccal glands in the lampreys has for a long time been a puzzle to zoolo-

gists. There is no sign of them present in the larval or ammocoetes stage; and they appear as wholly new structures on transformation. Their ducts open in the floor of the sucking mouth near the rasping tongue (fig. 1).

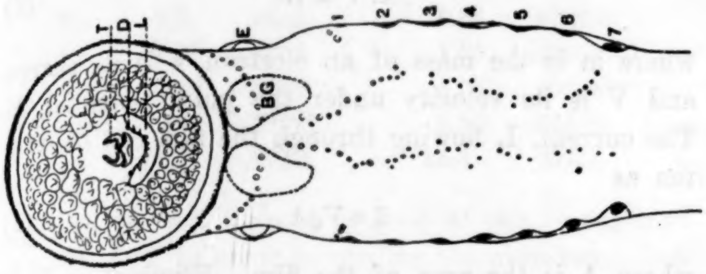

FIG. 1. Ventral view of the head and branchial region of a Lake Lamprey to show the position of the buccal glands and the opening of their ducts. BG. The bean-shaped, buccal glands at the level of the eyes (E). T. The rasping tongue. D. The duct-opening of the left buccal gland. L. The infraoral lamina. 1, 2, 3, 4, 5, 6, 7. The seven branchiopores or gill openings on the left side.

The wall of the sac-like gland is considerably folded and lined by a glandular epithelium. It is thus a combined secreting organ and a reservoir. Furthermore, for about three fourths of its circumference it has a special constricting capsule of striated muscle. In this respect it resembles the poison glands of snakes.

From the relation of the glands with the mouth, they are frequently spoken of as salivary glands, but their structure is not at all like ordinary salivary glands, and no proof has ever been given that the secretion has any digestive action.

At the only stage when these glands are present, the food of the lampreys is proteid in character, and consists almost wholly of blood from the fishes they prey upon, as one can see by examining the intestinal contents. Occasionally one may find traces of muscle or of other tissues torn (fig. 2) from its victim by the rasping tongue, but the main mass of the food as found by our many examinations has always been blood.

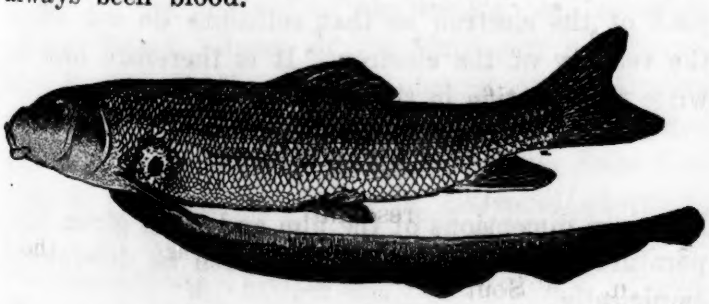

FIG. 2. Lake Lamprey attached to a fish. Above the pectoral and ventral fins are scars showing where other lampreys had made ragged openings with their rasping tongue.

In studying the structural arrangements of the lampreys for taking food it will be seen that the opening of the oesophagus is relatively small, and in Lampetra and Entosphenus especially, it is covered by a kind of grating. That is, the anatomical arrangement is adapted to the ingestion of liquid food. It is well known that the blood of fishes when it leaves the blood-vessels and comes in contact with the wounded tissues, clots very quickly. This is of course of great advantage to animals living in water, but it has two great disadvantages for the lampreys: It would not be so easy to swallow the clots as the liquid blood on the one hand, and on the other the clotting would tend to close the openings in the torn blood vessels and thus shut off the supply of food for the lamprey.

With this knowledge in mind, and remembering that the leech and the vampire bat have a secretion which they pour into the wounds they make in animals to prevent the blood from coagulating, it occurred to us that the lamprey's buccal-gland secretion might serve the same purpose.

Fortunately, by the aid of friends, a lake lamprey with the intestine full of blood was obtained, also some brook lampreys (Lampetra) early in the breeding season, and some of the secretion from the Pacific Coast lamprey (Entosphenus). Finally, by personal effort, many examples of the lake lamprey were caught when spawning. In all cases the secretion was obtained by aspirating it from the sac-like glands with a hypodermic syringe.

To test the hypothesis, the buccal-gland secretion of the lake lamprey was mixed with the blood of a bony fish (Amiurus), such as the lamprey often feeds upon. It entirely prevented the coagulation of the blood if in sufficient quantity. If the relative amount of blood was too great, the coagulation was delayed, but the fibrin filaments appeared in the end. In all cases the gland secretion tended to distort the red corpuscles and to haemolyze them. If the secretion was in excessive amount it extracted the haemoglobin very quickly, and in some cases seemed to destroy the corpuscles entirely, leaving only a granular mass. If the blood from the heart was put directly into the gland secretion, clotting did not occur and the corpuscles settled, leaving a straw-colored serum on top. Furthermore, when the buccal-gland secretion of a lamprey was mixed with its own blood, coagulation was prevented.

The buccal-gland secretion of all the lampreys when mixed with human blood delayed or prevented the coagulation. If a sufficient amount were used,

no fibrin ever appeared, but if a smaller relative amount were used the clotting was delayed, but the fibrin filaments finally appeared, thus resembling the action on fish blood.

For all of the experiments, the dark-field microscope was used. In this way the minutest amount of fibrin could be detected. The action was tested upon human blood from many different racial stocks —English, Norwegian, Dutch, Hebrew, etc. The action was uniform in all cases.

There was one striking difference between the action of the buccal-gland secretion of the lake lamprey (Petromyzon marinus unicolor) and that from Lampetra and Entosphenus. With the lake-lamprey secretion the human red corpuscles were prevented from forming rouleaux, but with the secretion from Lampetra and Entosphenus, the red corpuscles did form rouleaux although the fibrin formation was prevented as with the lake-lamprey secretion. In this respect, the Lampetra and Entosphenus secretion resembled the action of the sample of hirudin from the leech with which we experimented.

It is hoped that a full account of the development and structure of this interesting organ and the action of its secretion can be published with full illustrations in the near future.

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MARY GAGE-DAY

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EQUATION OF ELECTRONIC CONDUCTION IN UNI-POLAR NON-METALLIC FILMS

THE equation for variation of current flowing through a uni-polar non-metallic film due to electronic conduction when the film is in intimate contact with a metal can be derived by the use of Poisson's potential equation, in a manner similar to the method used by Langmuir (*Phys. Rev.* 1913, II, p. 453; *Gen. Elec. Rev.* 1915, p. 330) in studying the effect of the space charge on the emission of electrons from hot filaments.

In the simple case of an infinite plane emitting surface and an infinite parallel conducting plane, we have from Poisson's equation

$$\frac{d^2E}{dx^2} = -4\pi\varrho \qquad (1)$$

where E is the potential due to the space charge at point x along a line perpendicular to the planes, and ϱ is the volume density of the space charge. Consider a current flowing from the metal through the film in such intimate contact that electrons emitted from the surface of the metal penetrate into the film. If the concentration of free electric carriers in the non-metallic film is normally so small that it can be neglected, then at the boundary between metal and film we can then write $E = 0$, so that, neglecting any initial velocity of electrons emitted from the surface of the metal, we can write for the kinetic energy,

$$\frac{1}{2} m V^2 = Ee \qquad (2)$$

where m is the mass of an electron, e is its charge, and V is its velocity under the point potential, E. The current, I, flowing through the film can be written as

$$I = V\varrho A \qquad (3)$$

where A is the area of the film. Eliminating V in these equations and substituting in Poisson's equation to eliminate ϱ we obtain

$$\frac{d^2E}{dx^2} = \frac{4\pi I}{A}\sqrt{\frac{m}{2Ee}} \qquad (4)$$

the space charge, ϱ, being taken as negative on account of the negative charge of the electron. Integrating this equation subject to $\frac{dE}{dx} = 0$ when $E = 0$ gives

$$\left(\frac{dE}{dx}\right)^2 = \frac{8\pi I}{A}\sqrt{\frac{2mE}{e}} \qquad (5)$$

Integrating a second time, and solving for the current, we have finally,

$$I = \frac{A}{9\pi}\sqrt{\frac{2e}{m}}\,\frac{E^{3/2}}{x^2} \qquad (6)$$

Considering the flow of current in the opposite direction, *i.e.*, from film to metal with which it is in intimate relation, the emission of electrons from the film contact electrode is very feeble; first, because the two are not in intimate relation, and second, because of its reluctance to part with electrons. In this case the same form of equation as given in (6) will hold.

Insufficient data are available to verify the coefficients of equation (6). Furthermore equation (2) holds only for film thicknesses less than the mean free path of the electron so that collisions do not affect the velocity of the electron. It is therefore best to write the equation in the form

$$I = kE^{3/2} \qquad (7)$$

for given dimensions of the film and for a given temperature. The constant, k, may then be determined empirically.

The form of equation (7) may be tested from data obtained experimentally by Grondahl (*Jour. A. I. E. E.*, March, 1927, p. 216), who has made measurements on the current flowing in both directions through a copper oxide film on a copper disk. The observed values of I_1 and I_2 are compared with

those calculated from equation (7) when $k_1 = 1.79$ and $k_2 = .00017$.

	Observed		Calculated	
E	I_1	I_2	I_1	I_2
0	0	0	0	0
0.5	0.7	.0001	0.64	.000063
1.0	1.8	.0002	1.79	.00017
2.0	5.2	.0005	5.06	.00048
3.0	9.0	.0008	9.30	.00088
4.0	14.0	.0012	14.3	.00136

The agreement is about as good as can be expected on account of the error in reading the observed values of the current from a small scale curve.

The derivation of these equations have been based upon the theory of this phenomenon suggested by Grondahl (SCIENCE, Sept. 24, 1926, p. 306).

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NEW YORK, N. Y.

THE AMERICAN CHEMICAL SOCIETY

MEETING OF THE COUNCIL

THE Council of the American Chemical Society, President George D. Rosengarten presiding, and with 120 councilors in attendance, met at Detroit on the afternoon of September 5.

The section of history of chemistry having held successfully the six meetings prescribed by the council petitioned that it be made a division of the society and this request was granted and the by-laws submitted approved. New by-laws presented by the division of chemistry of medicinal products were also approved. A proposal that a section of chemical economics should be organized was discussed and without formal vote referred to the division of industrial and engineering chemistry, under the auspices of which symposia will be held to determine interest in the subject.

A. B. Lamb, of Harvard University, was reelected editor of the *Journal* of the society, and associate editors Roger Adams, of the University of Illinois, and E. W. Washburn, chief chemist of the Bureau of Standards, Washington, D. C., were reelected members of his board. E. J. Crane, Ohio State University, was reelected editor of *Chemical Abstracts*, and H. E. Howe, of Washington, editor of *Industrial and Engineering Chemistry*. W. A. Noyes, of Urbana, Ill., was reelected editor of the *Scientific Series of Monographs*, and H. E. Howe, editor of the *Technologic Series*. F. A. Lidbury, of Niagara Falls, N. Y., A. D. Little, Cambridge, Mass., and C. E. K. Mees, of Rochester, N. Y., were reelected to the technologic monograph board. H. S. Taylor, of Princeton, and W. A. Patrick, of Johns Hopkins University, were elected as society representatives on the editorial board of the *Journal of Physical Chemistry*. William McPherson, of Ohio State University, was reelected a member of the society's executive committee.

The president of the society having been asked to lend his name to the national committee being organized to secure the financial participation of the United States in the erection of a Maison de la Chimie in Paris in commemoration of the centenary of the birth of Marcelin Berthelot in which memorial building is intended to house the international office of chemistry. the formation of which is to be undertaken through diplomatic channels next May, the president called upon the secretary to read the papers in the matter and to give the history of recent movements looking toward the creation in one of the capitals of Europe of international control of chemistry. Following the complete statement which included the request of the president for advice from the society's executive committee, the following was presented for the council's action:

President George D. Rosengarten, of the American Chemical Society, having asked counsel of his advisers regarding a communication from M. Maurice Leon, vice-chairman of the "American Organization Committee for American Participation in a Maison de la Chimie" requesting the use of his name as a member of the committee, the executive committee of the Society unanimously advise him to decline for the reason that his acceptance would tacitly commit the American Chemical Society to a project it can not approve.

The American Chemical Society is glad to honor the name and accomplishments of Marcelin Berthelot and in evidence thereof has appointed two of its own past presidents to represent it at the centenary celebration on October 25, 1927. An international "Maison de la Chimie" and "An International Office of Chemistry" nationally conceived with predetermined control and location in Paris is an entirely different matter to which the American Chemical Society can not give its adherence, even though it has been connected with so eminent a name as Berthelot to insure its success.

The American Chemical Society has naught but good wishes for the "Chemists' Club" of New York, the long considered "House of Chemistry" of Great Britain, the "Hofmann House" of Berlin, or for a national "Maison de la Chimie" to be located in Paris and would be glad to see any of its members, who are so inclined, contribute to their support. It can not, however, admit the propriety of any national group assuming the right to centralization of control of international chemistry within its own territory and sphere of influence, even if the major costs of construction and upkeep of such an institution were not assessed upon the rest of the world.

The American Chemical Society believes that if an International Office of Chemistry, having as its object

the centralization of influence of chemical science, both pure and applied, is ever deemed desirable or necessary, it should be inspired through cooperative action of the world's scientific chemical organizations and not by governments through political channels.

The American Chemical Society does not approve any world centralization of control of chemistry and believes that the future progress of chemistry can best be served as heretofore by harmonious cooperation of national organizations.

The society specifically disclaims any discourtesy to the organizers of the present movement, but believes the underlying principle to be so detrimental to continued international cooperation that it would be lacking in probity if it did not make its judgment known.

After a few questions it was moved and carried that the council approve the advice given by the executive committee. The motion was then carried, without dissenting vote, that the secretary be directed to inform those government officials before whom the question of the office of international chemistry might come of the society's position.

The report of Dean Wendt, director of the first session of the Institute of Chemistry of the American Chemical Society, was presented and accepted with thanks to all those who had been active in furthering the interests of the institute.

At the Richmond meeting it was requested that a by-law be framed regarding the Endowment Fund and the following By-law No. 22 was adopted: The Endowment Fund of the society shall, Article 4, Sec. 2, of the Constitution of the Society, be collected and administered in two parts: (1) A permanent fund, the income of which alone may be expended only to help meet the society's constantly growing need for funds to record the results of chemical research in its publications; and (2) a revolving fund limited to \$100,000 to insure the publication of successive decennial indices to *Chemical Abstracts*, the sales of which shall be credited to the fund until the \$100,000 has been reached or replenished. Any excess above \$100,000 in the Revolving Fund at the end of any fiscal year may be used for the same purposes as the income of the permanent fund.

The report of the executive committee made by direction of the council at the Richmond meeting concerning a proposal that an Institute for Chemical Education be established was presented and referred to the society's committee of chemical education. The report in part follows: At the Richmond meeting the council referred to the executive committee for consideration and report the recommendation of the committee on chemical education that there be approved an Institute of Chemical Education. Although the resolution specifies that in all financial details such an institute shall be subject to final approval by the directors and in other matter to the approval of the executive committee or the council, the committee feels that as referred to it details concerning such an institute are as yet too nebulous to enable intelligent action to be taken. While it is understood that the discussion of such a research institute, both in the senate of chemical education and in the committee on chemical education, centered around the tentative plan published in the *Journal of Chemical Education* in January, 1927, it has been stated in conversation by several members both of the senate and of the committee that there is a lack of agreement with respect to the plan published. However, resulting discussion has brought forward several points worthy of further consideration.

Therefore, while the executive committee feels that the matter is not in a form sufficiently definite to enable it to give either a negative or an affirmative answer, it has seemed best to present in this report to the council a suggestion for the initiation of work in which we are all interested, with the recommendation that the committee on chemical education give it careful study and consideration, with the hope that from it will come a more definite plan upon which the council and the directors can take action.

A new amendment to the constitution was proposed whereby there would be added to the list of officers a president-elect who, at the end of one year, would automatically become president of the society. While president-elect he would serve upon the board of directors, the executive committee, and as a member of the council, thereby gaining an insight into the affairs of the society before assuming the responsibility of the presidency. This suggestion was automatically referred to a committee to be appointed by the president and which will later report to the council.

The council stood in respectful silence in memory of members deceased since the spring meeting. These included the following: F. T. Bayles, of Indianapolis, Ind.; Bertram B. Boltwood, of Yale University; J. G. Edward Cullmann, Lock Haven, Pa.; Edward H. Darby, Rome, N. Y.; Herbert M. Hill, Buffalo, N. Y.; Norman E. Holt, London, England; Victor Lenher, University of Wisconsin; C. F. Mabery, Case School of Applied Science (retired); H. P. Talbot, Massachusetts Institute of Technology, and Geoffrey Weyman, Newcastle-upon-Tyne, England.

The council accepted the invitation of the Minnesota Section, the headquarters of which are in Minneapolis, to hold the annual or autumn meeting in that city in 1929.

CHARLES L. PARSONS,
Secretary